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(71) Applicant *(for all designated States except US)*: KONINKLIJKE PHILIPS ELECTRONICS N.V. [NL/NL]; Groenewoudseweg 1, NL-5621 BA Eindhoven (NL).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: HARVEY, Paul, R. [GB/NL]; c/o Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL). VAN DEN BRINK, Johan, S. [NL/NL]; c/o Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL).

(74) Agent: COHEN, Julius, S.; Philips Intellectual Property & Standards, Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL).

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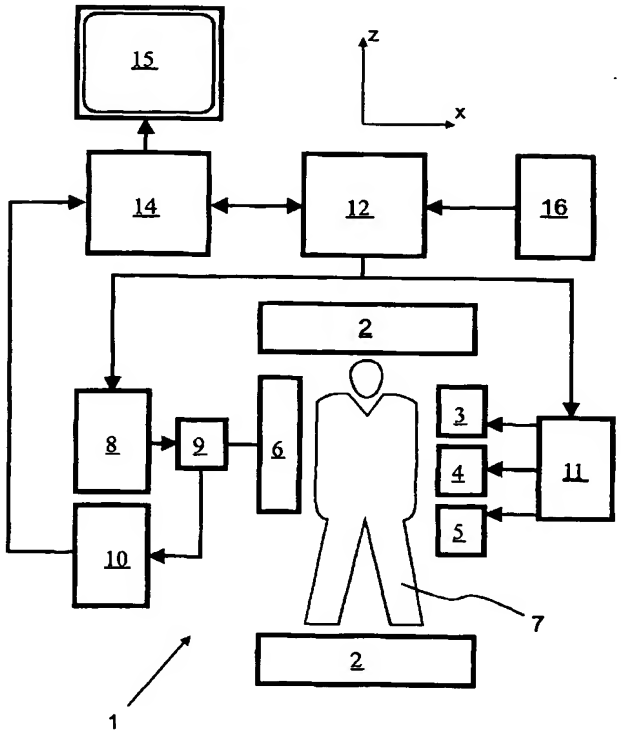
(54) Title: MAGNETIC RESONANCE METHOD AND DEVICE



(57) Abstract: The invention relates to a method for magnetic resonance imaging (MRI) of at least a portion of a body placed in a stationary and substantially homogeneous main magnetic field. The method comprises the steps of subjecting the body to a diffusion-weighting sequence (DW1), generating a train of MR echoes (E1, E2, E3, E4, E5) by an imaging sequence (EPI1), and measuring this train of MR echoes. These steps are repeated until a complete imaging data set with a sufficient number of phase-encoding steps is measured. Thereafter, the imaging data set is corrected for macroscopic motions by means of an individual phase-correction of each train of MR echoes. Finally, an image is reconstructed from the imaging data. In order to provide a method for diffusion-weighted imaging, which requires a minimum additional measurement time for determining the phase errors of the imaging signals and which also guarantees a robust compensation of image artifacts caused by macroscopic motions of the body of the examined patient, the invention suggests to select the phase-encoding scheme of the imaging sequence such that each train of MR echoes (E1, E2, E3, E4, E5) comprises at least one initial MR navigator echo (E1), which forms an integral part of the imaging data set, wherein the phase-correction is derived from this MR navigator echo.

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Declaration under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii)) for the following designations AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM, ZW, ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)*

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A. CLASSIFICATION OF SUBJECT MATTER
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B. FIELDS SEARCHED

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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
WPI Data, PAJ, INSPEC, EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 02 068978 A (MAX PLANCK GESELLSCHAFT ;DRIESEL WOLFGANG (DE); NORRIS DAVID (NL)) 6 September 2002 (2002-09-06) page 4, paragraph 3 -page 17, paragraph 1 page 21, paragraph 2 -page 27, paragraph 2 figure 5 ---	1-3,8-10
A	WO 98 47015 A (KONINKL PHILIPS ELECTRONICS NV ;PHILIPS SVENSKA AB (SE)) 22 October 1998 (1998-10-22) page 2, line 11 -page 4, line 20 page 5, line 24 -page 7, line 29 page 9, line 14 -page 11, line 4 figures 2,5,6 & US 6 076 006 A 13 June 2000 (2000-06-13) cited in the application --- -/--	1-3,8-10

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Volmer, W

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	BOSAK E ET AL: "Navigator motion correction of diffusion weighted 3D SSFP imaging" MAGNETIC RESONANCE MATERIALS IN PHYSICS, BIOLOGY AND MEDICINE, vol. 12, 2001, pages 167-176, XP002268114 ISSN: 1352-8661 pages 167 - 169: paragraphs 1 and 2 ---	1-3,8-10
A	BAMMER R ET AL: "Diffusion-weighted imaging with navigated interleaved echo-planar imaging and a conventional gradient system" RADIOLOGY, vol. 211, 1999, pages 799-806, XP002268115 ISSN: 0033-8419 pages 800 - 803: "MATERIALS AND METHODS" -----	1,8,9

INTERNATIONAL SEARCH REPORT

Information on patent family members

In onal Application No
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 02068978 A	06-09-2002	DE 10109511 A1	19-09-2002
		WO 02068978 A2	06-09-2002
WO 9847015 A	22-10-1998	WO 9847015 A1	22-10-1998
		EP 0910804 A1	28-04-1999
		JP 2000512533 T	26-09-2000
		US 6076006 A	13-06-2000